

WHAT IS CLAIMED IS:

1 1. An apparatus comprising:
2 a sign extractor having an input and first and
3 second outputs, wherein the input of the sign extractor
4 receives an input signal, wherein the first output
5 provides a sign of the input signal, and wherein the
6 second output provides a magnitude of the input signal;
7 a delay coupled to the first output, wherein
8 the delay imposes a delay on the sign;
9 a square root extractor coupled to the second
10 output, wherein the square root extractor has an output
11 that provides an output signal, wherein the output signal
12 is an approximation to a square root of the magnitude of
13 the input signal; and,
14 a sign restorer coupled to the output of the
15 square root extractor and to the delay, wherein the sign
16 restorer applies the sign from the delay to the output
17 signal from the square root extractor.

1 2. The apparatus of claim 1 wherein the input
2 signal is a digital signal.

1 3. The apparatus of claim 2 wherein the input
2 signal is complemented by the sign extractor to produce a
3 signal having a positive sign bit and a signal having a
4 negative sign bit, and wherein the sign extractor selects
5 the signal having the positive sign bit to provide to the
6 second output of the sign extractor.

1 4. The apparatus of claim 1 wherein the
2 square root extractor comprises first and second stages.

1 5. The apparatus of claim 4 wherein the delay
2 is a first delay, and wherein the first stage comprises:
3 a first multiplier arranged to form a product
4 of the magnitude of the input signal and an approximation
5 of an inverse of the square root of the magnitude of the
6 input signal;

7 a summer arranged to add an output of the first
8 multiplier to an approximation of the square root of the
9 magnitude of the input signal;

10 a scaler arranged to scale an output of the
11 summer substantially by $\frac{1}{2}$; and,

12 a second delay having an input coupled to the
13 output of the scaler, wherein the second delay is

14 arranged to pass the approximation of the square root of
15 the magnitude of the input signal to the summer, and
16 wherein the second delay has an output coupled to an
17 input of the second stage.

1 6. The apparatus of claim 5 wherein the
2 second stage comprises:

3 a second multiplier arranged to form a product
4 of the input to the second stage with an output of the
5 second stage;

6 a subtractor arranged to subtract an output of
7 the second multiplier from a constant substantially equal
8 to two;

9 a third multiplier arranged to form a product
10 of an output of the subtractor with the output of the
11 second stage and to provide the approximation of the
12 inverse of the square root of the magnitude of the input
13 signal; and,

14 a third delay coupled to an output of the third
15 multiplier and arranged to provide the output of the
16 second stage.

1 7. The apparatus of claim 1 wherein the sign
2 restorer comprises a multiplier, and wherein the
3 multiplier multiplies the output signal from the square
4 root extractor by the sign provided by the first output
5 of the sign extractor.

1 8. The apparatus of claim 1 wherein the
2 square root extractor consists of multiplying, summing,
3 scaling, and delaying functions.

1 9. The apparatus of claim 1 wherein the delay
2 is a first delay, wherein the square root extractor
3 comprises first, second, and third multipliers, first and
4 second summers, second and third delays, and a scaler,
5 wherein the first multiplier has a first input coupled to
6 the second output of the sign extractor and a second
7 input coupled to an output of the third multiplier,
8 wherein the first summer has a first input coupled to an
9 output of the first multiplier and a second input coupled
10 to an output of the second delay, wherein the scaler has
11 an input coupled to an output of the first summer and an
12 output coupled to an input of the second delay, wherein
13 the second multiplier has a first input coupled to the

14 output of the second delay and a second input coupled to
15 an output of the third delay, wherein the second summer
16 has a first input coupled to an output of the second
17 multiplier and a second input coupled to a constant,
18 wherein the third multiplier has a first input coupled to
19 an output of the second summer and a second input coupled
20 to the output of the third delay, and wherein the third
21 delay has an input coupled to the output of the third
22 multiplier.

1 10. The apparatus of claim 9 wherein the
2 scaler applies a scaling function substantially equal to
3 one-half, and wherein the constant is substantially equal
4 to two.

1 11. The apparatus of claim 1 wherein the delay
2 is a first delay, wherein the square root extractor
3 comprises first, second, and third multipliers, first and
4 second summers, second and third delays, and a scaler,
5 wherein the first multiplier has a first input coupled to
6 the second output of the sign extractor and a second
7 input coupled to an output of the third multiplier,
8 wherein the first summer has a first positive input

9 coupled to an output of the first multiplier and a second
10 positive input coupled to an output of the second delay,
11 wherein the scaler has an input coupled to an output of
12 the first summer and an output coupled to an input of the
13 second delay, wherein the second multiplier has a first
14 input coupled to the output of the second delay and a
15 second input coupled to an output of the third delay,
16 wherein the second summer has a negative input coupled to
17 an output of the second multiplier and a positive input
18 coupled to a constant, wherein the third multiplier has a
19 first input coupled to an output of the second summer and
20 a second input coupled to the output of the third delay,
21 and wherein the third delay has an input coupled to an
22 output of the third multiplier.

1 12. The apparatus of claim 11 wherein the
2 scaler applies a scaling function substantially equal to
3 one-half, and wherein the constant is substantially equal
4 to two.

1 13. A square root extractor consisting of
2 multiplying, summing, scaling, and delaying functions.

1 14. The square root extractor of claim 13
2 wherein the multiplying function comprises first, second,
3 and third multipliers, wherein the summing function
4 comprises first and second summers, wherein the delaying
5 function comprises first and second delays, wherein the
6 scaling function comprises a scaler, wherein the first
7 multiplier has a first input coupled to receive a signal
8 whose square root is to be extracted and a second input
9 coupled to an output of the third multiplier, wherein the
10 first summer has a first input coupled to an output of
11 the first multiplier and a second input coupled to an
12 output of the first delay, wherein the scaler has an
13 input coupled to an output of the first summer and an
14 output coupled to an input of the first delay, wherein
15 the first delay provides an output of the square root
16 extractor, wherein the second multiplier has a first
17 input coupled to the output of the first delay and a
18 second input coupled to an output of the second delay,
19 wherein the second summer has a first input coupled to an
20 output of the second multiplier and a second input
21 coupled to a constant, wherein the third multiplier has a
22 first input coupled to an output of the second summer and
23 a second input coupled to the output of the second delay,

24 and wherein the second delay has an input coupled to the
25 output of the third multiplier.

1 15. The square root extractor of claim 14
2 wherein the scaler applies a value substantially equal to
3 one-half, and wherein the constant is substantially equal
4 to two.

1 16. The square root extractor of claim 13
2 wherein the multiplying function comprises first, second,
3 and third multipliers, wherein the summing function
4 comprises first and second summers, wherein the delaying
5 function comprises first and second delays, wherein the
6 scaling function comprises a scaler, wherein the first
7 multiplier has a first input coupled to receive a signal
8 whose square root is to be extracted and a second input
9 coupled to an output of the third multiplier, wherein the
10 first summer has a first positive input coupled to an
11 output of the first multiplier and a second positive
12 input coupled to an output of the first delay, wherein
13 the scaler has an input coupled to an output of the first
14 summer and an output coupled to an input of the first
15 delay, wherein the first delay provides an output of the

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16 square root extractor, wherein the second multiplier has
17 a first input coupled to the output of the first delay
18 and a second input coupled to an output of the second
19 delay, wherein the second summer has a negative input
20 coupled to an output of the second multiplier and a
21 positive input coupled to a constant, wherein the third
22 multiplier has a first input coupled to an output of the
23 second summer and a second input coupled to the output of
24 the second delay, and wherein the second delay has an
25 input coupled to the output of the third multiplier.

1 17. The square root extractor of claim 16
2 wherein the scaler applies a value substantially equal to
3 one-half, and wherein the constant is substantially equal
4 to two.

1 18. A square root extractor comprising first,
2 second, and third multipliers, first and second summers,
3 first and second delays, and a scaler, wherein the first
4 multiplier has a first input coupled to receive a signal
5 whose square root is to be extracted and a second input
6 coupled to an output of the third multiplier, wherein the
7 first summer has a first input coupled to an output of

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8 the first multiplier and a second input coupled to an
9 output of the first delay, wherein the scaler has an
10 input coupled to an output of the first summer and an
11 output coupled to an input of the first delay, wherein
12 the output of the first delay provides an output of the
13 square root extractor, wherein the second multiplier has
14 a first input coupled to the output of the first delay
15 and a second input coupled to an output of the second
16 delay, wherein the second summer has a first input
17 coupled to an output of the second multiplier and a
18 second input coupled to a constant, wherein the third
19 multiplier has a first input coupled to an output of the
20 second summer and a second input coupled to the output of
21 the second delay, and wherein the second delay has an
22 input coupled to the output of the third multiplier.

1 19. The square root extractor of claim 18
2 wherein the scaler applies a scaling function
3 substantially equal to one-half.

1 20. The square root extractor of claim 18
2 wherein the constant is substantially equal to two.

1 21. The square root extractor of claim 20
2 wherein the scaler applies a scaling function
3 substantially equal to one-half.

1 22. The square root extractor of claim 18
2 wherein the first input of the first summer comprises a
3 first positive input, wherein the second input of the
4 first summer comprises a second positive input, wherein
5 the first input of the second summer comprises a negative
6 input, and wherein the second input of the second summer
7 comprises a positive input.

1 23. The square root extractor of claim 22
2 wherein the scaler applies a scaling function
3 substantially equal to one-half, and wherein the constant
4 is substantially equal to two.

1 24. A method comprising:
2 multiplying first and second signals to produce
3 a third signal, wherein the first signal is a signal
4 whose square root is to be extracted;
5 summing the third signal and a fourth signal to
6 produce a fifth signal;

7 scaling the fifth signal to produce a sixth
8 signal;
9 delaying the sixth signal to produce the fourth
10 signal;
11 multiplying the fourth signal and a seventh
12 signal to produce an eighth signal;
13 subtracting the eighth signal from a constant
14 to produce a ninth signal;
15 multiplying the ninth signal and the seventh
16 signal to produce the second signal; and,
17 delaying the second signal to produce the
18 seventh signal, wherein both the fourth signal and the
19 sixth signal are approximations to the square root of the
20 first signal, and wherein both the second signal and the
21 seventh signal are approximations to the reciprocal of
22 the square root of the first signal.

1 25. The method of claim 24 further comprising
2 multiplying the fourth signal by a sign.

1 26. The method of claim 24 wherein the
2 constant is equal to two, and wherein the scaling of the
3 fifth signal comprises scaling the fifth signal by one-

4 half to produce the sixth signal.

1 27. The method of claim 26 further comprising
2 multiplying the fourth signal by a sign.